PATENT ABSTRACTS OF JAPAN

(11)Publication number : 10-089345

(43)Date of publication of application : 07.04.1998

(51)Int.CI. F16C 17/02

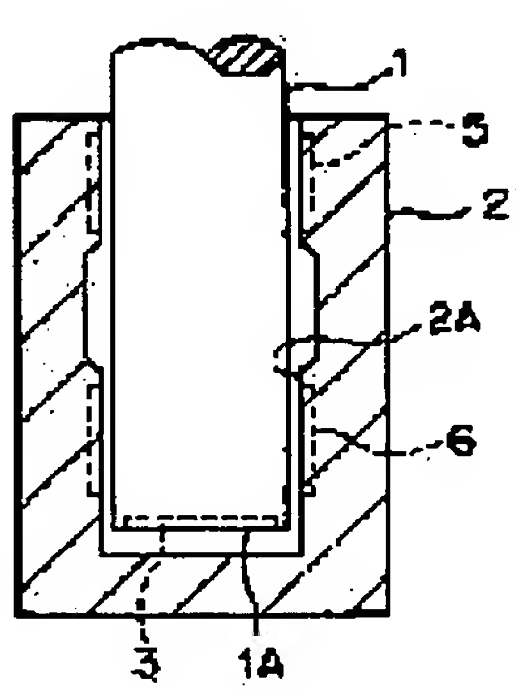
(21)Application number : 08-239060

(22)Date of filing : 10.09.1996

(71)Applicant : KOYO SEIKO CO LTD

(72)Inventor : TAKAHASHI TAKESHI
ONISHI MASAYOSHI
TAKAMURA YASUO

(54) DYNAMIC PRESSURE BEARING



(57)Abstract:

PROBLEM TO BE SOLVED: To provide an abrasion resistant shaft having a thermal expansion coefficient similar to that of a cupper alloy sleeve by forming the shaft of austenite stainless steel, and carrying out hardening treatment on the surface layer of the shaft.

SOLUTION: A sleeve 2 is made of cupper alloy, while a shaft 1 is made of austenite stainless steel and SUS 303. A thermal expansion factor of the SUS. 303 K. (K1=16 × 10-617 × -10-6) [1/K] is similar to the thermal expansion factor K, of cupper alloy as the material of the sleeve 2 (K2,=17 × 10-618 × 10-6 [1/K]). Even when a temperature varmes, accordmngly, a gap for generating dynamic pressure is hardly fluctuated. The shaft 1 is prepared by cutting SUS material to form a desired form, forming a dynamic pressure groove 3 by plastic processing, and finishing through

plishing. In addition, surface hardening is treated by nitriding. Due to this nitriding, surface hardness of the shaft 1 reaches 1000Hv, so that the shaft 1 has resistance to abrasion.

LEGAL STATUS

[Date of request for examination]	06.06.2002
[Date of sending the examiner's decision of rejection]	
[Kind of final disposal of application other than the examiner's decision of rejection or application converted registration]	
[Date of final disposal for application]	
[Patent number]	
[Date of registration]	
[Number of appeal against examiner's decision of rejection]	
[Date of requesting appeal against examiner's decision of rejection]	
[Date of extinction of right]	

CLAIMS

[Claim(s)]

[Claim 1] The hydrodynamic bearing characterized by having the shaft and sleeve which carry out a relative revolution, producing the above-mentioned sleeve with the copper alloy in the hydrodynamic bearing by which the dynamic pressure generating slot was formed in the peripheral face of the above-mentioned shaft, or the inner skin of the above-mentioned sleeve, producing the above-mentioned shaft with a copper alloy and the austenitic stainless steel which has the coefficient of thermal expansion to approximate, and hardening processing being made by the surface layer of the above-mentioned shaft.

[Claim 2] It is the hydrodynamic bearing characterized by the above-mentioned hardening processing being nitriding treatment in a hydrodynamic bearing according to claim 1.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Field of the Invention] This invention relates to a hydrodynamic bearing.

[0002]

[Description of the Prior Art] Although there are some which produced the sleeve with the copper alloy with sufficient workability as a hydrodynamic bearing conventionally equipped with the shaft which carries out a relative revolution, and a sleeve, the sleeve, shaft, and differential thermal expansion made from a copper alloy are lessened in this case, and an ideal lessens clearance change by the temperature change.

[0003] However, there was no hydrodynamic bearing equipped with a shaft it has a shaft and a coefficient of linear expansion equivalent to the sleeve made from a copper alloy and the degree of hardness which can make abrasive (scratching) wear slight. [0004]

[Problem(s) to be Solved by the Invention] Then, the object of this invention is in a hydrodynamic bearing equipped with the sleeve made from a copper alloy to offer the hydrodynamic bearing equipped with a shaft it has a shaft and a coefficient of linear expansion equivalent to the sleeve made from a copper alloy, and the degree of hardness which can make abrasive (scratching) wear slight.

[0005]

[Means for Solving the Problem] It has the shaft and the sleeve in which the hydrodynamic bearing of invention of claim 1 carries out a relative revolution, in order to attain the above-mentioned object, the above-mentioned sleeve is produced with a copper alloy, and it is produced with the austenitic stainless steel which it has in the coefficient of thermal expansion which the above-mentioned shaft approximates with

a copper alloy in the hydrodynamic bearing by which the dynamic-pressure generating slot was formed in the peripheral face of the above-mentioned shaft, or the inner skin of the above-mentioned sleeve, and it is carrying out that hardening processing is made by the surface layer of the above-mentioned shaft as the description.
[0006] According to this invention, since the austenitic stainless steel which produces a shaft has the coefficient of thermal expansion to approximate upwards with a copper alloy and hardening processing is made by the surface layer, the hydrodynamic bearing which temperature fluctuation of the clearance for dynamic pressure generating equipped with the shaft strong also against abrasive wear small to the sleeve made from a copper alloy can be offered.
[0007] Moreover, invention of claim 2 is characterized by the above-mentioned hardening processing being nitriding treatment in the hydrodynamic bearing according to claim 1.
[0008] According to this nitriding treatment, there is little heat treatment distortion given to the surface layer of a shaft, and it ends.
[0009]
[Embodiment of the Invention] Hereafter, the gestalt of implementation of a graphic display explains this invention to a detail.
[0010] The gestalt of operation of the hydrodynamic bearing of this invention is shown in drawing 1 . This operation gestalt is equipped with the shaft 1 and sleeve 2 which carry out a relative revolution. The dynamic pressure slot 3 for axial support is formed in shaft-orientations end-face 1A of a shaft 1. Moreover, the dynamic pressure slots 5 and 6 for radial support are formed in inner skin 2A of a sleeve 2.
[0011] The above-mentioned sleeve 2 is produced with the copper alloy. On the other hand, the shaft 1 is produced with austenitic stainless steel. SUS303 was used as this austenitic stainless steel. coefficient-of-thermal-expansion K1=16x10 of SUS303 -- coefficient-of-thermal-expansion K2=17x10 of the copper alloy whose -six to 17x10-6 [1/K] is the ingredient of a sleeve 2 -- since it is close to -six to 18x10-6 [1/K], even if temperature changes, the clearance for dynamic pressure generating hardly changes. Moreover, SUS303 which is OSU tee night system stainless steel is excellent in corrosion resistance and machinability compared with martensitic stainless steel.
[0012] Moreover, after making the above-mentioned shaft 1 into a necessary configuration in cutting at the above-mentioned SUS material, the above-mentioned dynamic pressure slot 3 is formed in plastic working (coining), after that, finish-machining is made by polish and surface hardening is further made as nitriding

treatment is also. According to this nitriding treatment, there is an advantage in which there is little heat treatment distortion given to the surface layer of a shaft 1, and it lives. What is necessary is just to adopt ** salt bath nitriding, ** plasma nitriding, and ** gas soft nitriding as this nitriding treatment.

[0013] ** Salt-bath-nitriding ******** tufftriding is processing which the salt bath of the steel is carried out by cyanic-acid ghosts (KCNO, NaCNO, etc.) only for about 2 to 3 hours in the state of 520 degrees C - 580 degrees C heating, and the activity nitrogen N generated by decomposition of the above-mentioned cyanic-acid ghost invades on the surface of steel, and forms a nitriding compound in this front face. By this processing, 1000 or more are the surface hardness of steel by Vickers hardness number Hv.

[0014] ** If plasma nitriding encloses shade and positive two poles in a well-closed container, and decompresses internal pressure to 0.5 - 10Torr and the electrical potential difference of 100-1500V is impressed among two poles, glow discharge will generate it. Under the present circumstances, if glow discharge is performed in a container by using as cathode the shaft (shaft 1) which is going to introduce the mixed gas of H2 and N2, or NH3 gas, and it is going to nitride, the nitrogen under glow discharge is ionized and it collides on the surface of a processed material (shaft 1), and by the high kinetic energy which ion has, a processed material will be heated and nitriding will be performed.

[0015] ** Gas soft nitriding has what added NH3, and a thing using the carbonitriding nature gas which occurred by disassembly of a urea in a carburization nature ambient atmosphere. Each processing temperature makes target temperature the same temperature as salt bath nitriding. The gas endoergic mold carburization nature gas 50 volume %, NH350 volume %, and whose dew-point are 0 degree C is used for the former. Moreover, heat a urea quickly to 500 degrees C or more, and do not make a complicated polymerization cause, but it is made to decompose like a degree type, and the latter performs gas soft nitriding with the CO(NH2)2 -> CO+N2+2H2 generation CO and nascent state nitrogen. Both the former and the latter show the same property as salt bath soft nitriding.

[0016] Moreover, the fluoride processing with which the shaft 1 of the hydrodynamic bearing of the gestalt of this operation replaces the oxide of the front face of a processed material to the metal fluoride film as pretreatment of the above-mentioned nitriding treatment may be made. By performing the above-mentioned nitriding treatment after this fluoride processing, a precise nitrated case (10 micrometers of thickness) 1 micrometer or less is formed in the front face of a shaft 1 for the mean

particle diameter of a nitride. Thus, by a precise nitrated case being formed in the front face of a shaft 1, the oil film piece of the front face of a shaft 1 can be prevented, and good lubricity can be maintained.

[0017] According to the above-mentioned fluoride processing, foreign matters, such as processing aid with which the activated fluorine atom which is used for fluoride processing had adhered to the steel of shaft 1 front face of a base material, are destroyed and removed, and a front face is purified. Simultaneously, passive state film like the oxide film on the front face of steel is transposed to the metal fluoride film. Coat protection of the above-mentioned steel front face will be carried out with the metal fluoride film, and generation of an oxide will be prevented to next nitriding treatment by this replacement. Therefore, an oxide can be certainly removed from the steel front face before nitriding treatment, and precise, homogeneity, and sufficient nitrated case can be formed in a steel front face.

[0018] On the other hand, in not performing the above-mentioned fluoride processing, a metallic element like Cr, Mn, Si, and aluminum in steel tends to oxidize in a 480 degrees C - 700 degrees C temperature region in the case of nitriding treatment. And in the above-mentioned temperature field, since it is difficult to build the ambient atmosphere which maintains these metallic elements to neutrality or reducibility thoroughly, most above-mentioned metallic elements oxidize in the above-mentioned temperature field. The grain boundary oxide of steel is formed on the occasion of nitriding treatment, this grain boundary oxide serves as a failure, and nitriding treatment is checked by it. As a result, a nitrated case is hard to be formed on the surface of steel in stability.

[0019] On the other hand, since an oxide can be certainly removed from a steel front face as described above when performing the above-mentioned fluoride processing, it is stabilized and a fixed nitrated case can be formed. That is, the H2 above-mentioned gas destroys and removes the metal fluoride film which is carrying out coat protection of the steel front face at the temperature of about 350-450 degrees C by introducing in a furnace the mixed gas of the gas (for example, NH3 gas) and H2 gas which have a nitrogen source in the case of nitriding treatment. The metal base which was purified and was activated by this appears, N atom in nitriding gas (for example, NH3 gas) acts on this activated metal base, osmosis diffusion is carried out promptly and a deep nitrated case is formed in the interior at homogeneity. That is, the overly hard compound layer (nitrated case) which contains nitrides, such as CrN, Fe2N, Fe3N, and Fe4N, toward the inside from the front face of steel is deeply formed in homogeneity, the diffusion layer of hard N atom is formed following it, and the above-mentioned

compound layer + diffusion layer constitutes all nitrated cases. Moreover, the hardness of a nitrated case is also equivalent to the conventional tufftriding article, and surface hardness is maintaining Vickers hardness number 450Hv (test load 50gf).

[0020] As fluorine system gas used for fluoride processing with the gestalt of this operation, the gas of NF3, BF3, CF4, HF, SF6, and F2 which made independent or the source component of a fluorine which consists of mixture contain in the inert gas of N2 grade is used suitably. Especially, safety, reactivity, control nature, handling nature, etc. blend, NF3 is most excellent, and it is practical. By such fluorine system gas, the source component of a fluorine of NF3 grade is set as 0.05 % of the weight - 20% of the weight of concentration from the point of effectiveness. The source component of a fluorine of desirable one is 3 % of the weight - 5% of the weight of within the limits.

[0021] Vickers hardness number (Hv) distribution of the direction of a path of the shaft 1 with which gas-soft-nitriding processing of the above-mentioned ** was made after the fluoride processing as pretreatment which was described above is shown in drawing 2 . Surface hardness has reached 1000Hv(s) so that drawing 2 may show. Moreover, in a location with a depth [from a front face] of 0.2mm, Vickers hardness numbers are 265Hv(s). Moreover, in the core, hardness Hv is 240Hv(s). The part from an above-mentioned depth of 0.0mm to a depth of 0.2mm constitutes the surface layer 7 of a shaft 1.

[0022] Thus, since the surface hardness of a shaft 1 has reached 1000Hv(s), a shaft 1 becomes strong to abrasive wear. On the other hand, in the interior with a depth of 0.2mm or more with little nitriding by the above-mentioned nitriding treatment, the property of austenitic stainless steel (SUS303 or SUS304) is maintained, a coefficient of thermal expansion is 17.3x10-6 [1/K], modulus of direct elasticity is 197 [GPa], and a consistency is 8.03x103 [Kg/m3]. Therefore, in this interior, the coefficient of thermal expansion near the coefficient of linear expansion 17x10-6 to 18x10-6 of the sleeve 2 made from a copper alloy [1-/degree C] is maintained.

[0023] Therefore, according to the gestalt of this operation, the hydrodynamic bearing which temperature fluctuation of the clearance for dynamic pressure generating equipped with the shaft 1 strong also against abrasive wear small to the sleeve 2 made from a copper alloy is realizable.

[0024] In addition, with the gestalt of the above-mentioned implementation, although the shaft 1 was produced by SUS303, you may produce by SUS304.

[0025]

[Effect of the Invention] As mentioned above, the hydrodynamic bearing of this invention is equipped with the shaft and sleeve which carry out a relative revolution, in

the hydrodynamic bearing by which the dynamic pressure generating slot was formed in the peripheral face of the above-mentioned shaft, or the inner skin of the above-mentioned sleeve, the above-mentioned sleeve is produced with the copper alloy, the above-mentioned shaft is produced with a copper alloy and the austenitic stainless steel which has the coefficient of thermal expansion to approximate, and hardening processing is made by the surface layer of the above-mentioned shaft so that clearly.

[0026] According to this invention, since hardening processing is made by the surface layer of the shaft produced with a copper alloy and the austenitic stainless steel which has the coefficient of thermal expansion to approximate, the above-mentioned shaft becomes strong to abrasive wear, and it is hard coming to damage it. Therefore, according to this invention, the hydrodynamic bearing which temperature fluctuation of the clearance for dynamic pressure generating equipped with the shaft strong also against abrasive wear small to the sleeve made from a copper alloy is realizable.

[0027] Moreover, in a hydrodynamic bearing according to claim 1, the above-mentioned hardening processing of invention of claim 2 is nitriding treatment. According to this nitriding treatment, there is little heat treatment distortion given to the surface layer of a shaft, and it ends.

[Translation done.]

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1] It is drawing showing the gestalt of operation of the hydrodynamic bearing of this invention.

[Drawing 2] It is drawing showing degree-of-hardness distribution of the direction of a path of the shaft 1 of the gestalt of the above-mentioned implementation.

[Description of Notations]

1 [-- Inner skin, 3 / -- 5 The dynamic pressure slot for axial support, 6 / -- The dynamic pressure slot for radial support, 7 / -- Surface layer.] -- A shaft, 1A -- A shaft-orientations end face, 2 -- A sleeve, 2A

[Translation done.]

* NOTICES *

Japan Patent Office is not responsible for any damages caused by the use of this translation.

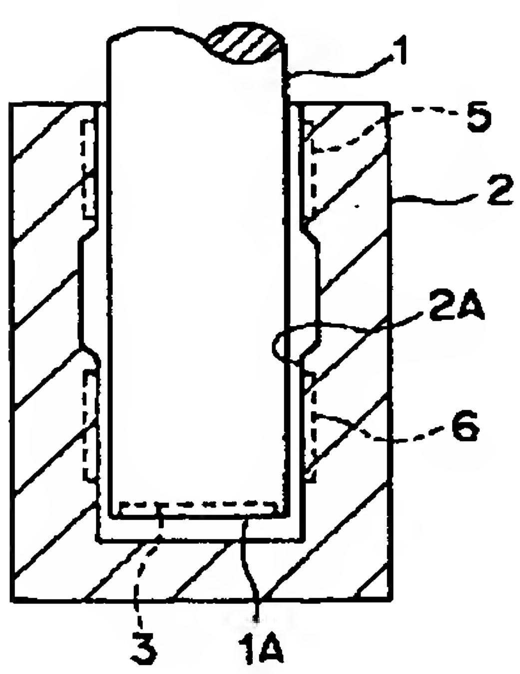
1.This document has been translated by computer. So the translation may not reflect the original precisely.

2.**** shows the word which can not be translated.

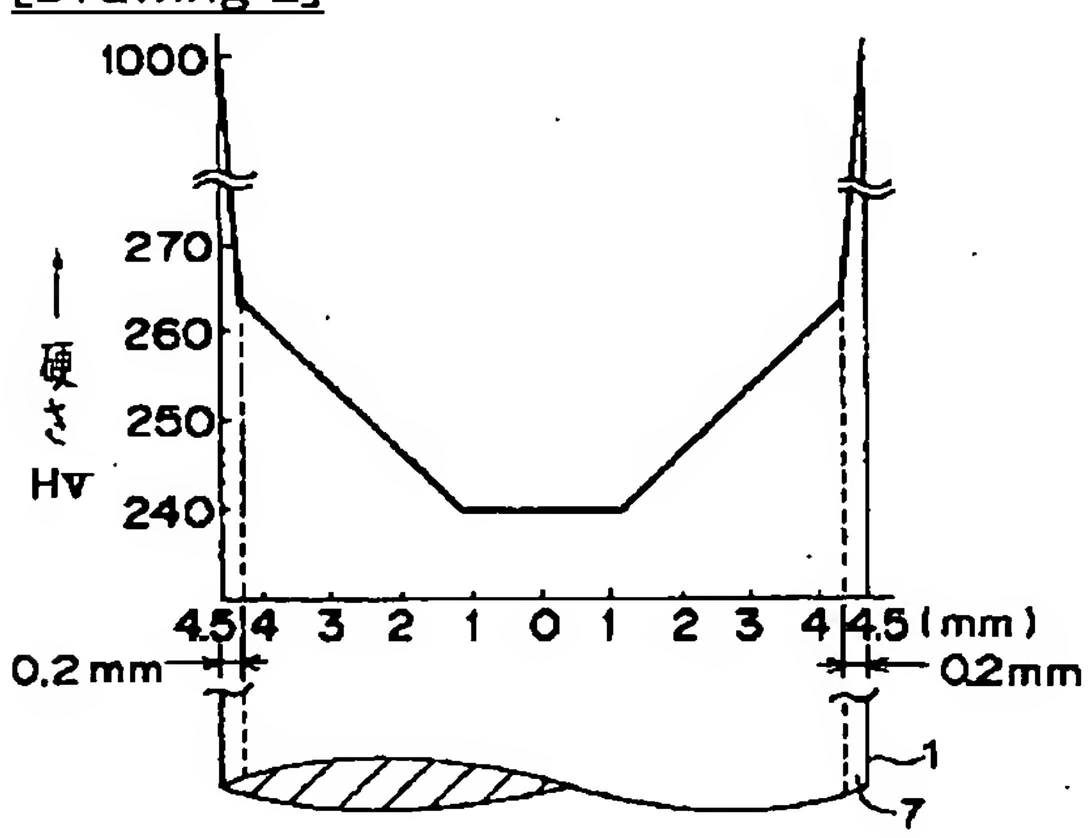
3.In the drawings, any words are not translated.

DRAWINGS

[Drawing 1]



[Drawing 2]



[Translation done.]